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INTERSTOCK TRIALS WITH GRAFTED COASTAL DOUGLAS-FIR

by

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Abstract

Seventeen compatible clones of coastal Douglas-fir were tested as interstocks between incompatible coastal scions and rootstocks. Interstocks did not reduce graft incompatibility between incompatible scion clones and seedling Douglas-fir rootstocks. Only 22 percent of the double-grafted trees had compatible upper and lower unions, whereas 48 percent of the same scion clones were compatible when single-grafted on the rootstocks. A three-way interaction among scion, interstock, and rootstock genotypes may have induced normally compatible scion-interstock combinations to become incompatible.

Keywords: Interstock, grafting, compatibility, incompatibility.

Orchards for production of genetically improved Douglas-fir (*Pseudotsuga menziesii*) seed were established in the Northwest 14 years ago. Rootstocks were grafted because cuttings from adult trees were difficult to root. Scions of adult trees were grafted onto juvenile rootstocks of known geographic source but random parentage. Many clones showed good compatibility, but incompatibility was a serious problem with many others (Copes 1968). Horticulturists have sometimes overcome incompatibility or provided a compatibility bridge in fruit trees by inserting a mutually compatible interstock between the incompatible scion and rootstock (Sax 1953). Little or no improvement in compatibility was achieved in a similar attempt when the Rocky Mountain strain

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of Douglas-fir from six Western States was tested as an intermediate between coastal Douglas-fir rootstocks and scions (Copes 1970). This paper reports testing of highly compatible Douglas-fir clones of coastal origin as interstocks between highly incompatible scions and seedling rootstocks. It is of particular interest because an unusual form of induced incompatibility at the scion-interstock union was discovered.

METHODS

Seventeen of the most compatible and 15 of the most incompatible clones grafted in western Oregon and Washington seed orchards were used as interstocks and scions, respectively. Selection was based solely on past performance in seed orchards.

In March 1966, eight of the 17 interstocks were grafted in the greenhouse on 200 potted 2-year-old seedling rootstocks of random parentage. Interstocks from each clone were grafted on 25 different rootstocks. One month later, five grafts of each of five scion clones were made on the 25 grafts of each interstock. The basic design used was a factorial of eight interstocks x five test clones grafted with five completely randomized replications of each interstock-test clone combination. Technique losses reduced the number actually tested to about 20 rootstocks per interstock. In addition, the scion clones were single-grafted on the rootstocks. Grafts were grown in the greenhouse the first summer and then placed in a lathhouse for the duration of the study. All the grafts were sacrificed for compatibility tests 18 months after the upper unions were grafted.

Comparable field tests with the remaining nine interstocks and 10 scion clones were installed at two locations in Oregon. Grafting was done in the field on 225 5- to 8-year-old rootstocks using an experimental design similar to that described for greenhouse grafts. Three interstocks and five scion clones were grafted at one location and six interstocks and five scion clones at the other. Interstock clones were grafted in 1965-67, but the scions were not grafted onto the interstocks until 1967-68. In addition, scion clones for three of the interstocks were single-grafted on the rootstocks in 1968. All unions were sacrificed for compatibility tests in the fall of 1968 or 1969.

Compatibility of both field- and greenhouse-grown grafts was estimated by the procedure described by Copes (1967). Sacrificed unions were sectioned with a sliding microtome, stained with safranin O and fast green, and then checked for presence of internal incompatibility symptoms (wound-xylem areas). A numerical estimate of average compatibility was obtained from the anatomical observations for each clone (number compatible

grafts : number of compatible + incompatible grafts). Interstock grafting was judged successful if the product of the average compatibilities of the upper union times lower union exceeded 70 percent.

RESULTS

The attempt to provide a compatibility bridge between incompatible scions and rootstocks was not successful. The hoped-for gain in compatibility at the scion-interstock union, due to good compatibility of the interstock genotypes, did not occur. Only 30 percent of the scion-interstock unions were compatible (table 1). When compared with single-grafting, double-grafting actually increased the number of incompatible ramets. Only 22 percent (75 x 30) of the double-worked trees were compatible, whereas 48 percent of the same scion clones were compatible when single-grafted on the same rootstocks. The general failure of the interstock method made detailed statistical analysis unnecessary.

Table 1.--*Compatibility of greenhouse- and field-grown grafts at the scion-interstock, interstock-rootstock, and scion-rootstock unions*

Interstock clone number	A, scion- interstock unions	B, interstock- rootstock unions	C, successful double-grafted ramets (AxB)	D, scion- rootstock unions
- - - - - Percent compatibility - - - - -				
Greenhouse:				
10	61	62	38	59
7	46	76	34	53
1	55	74	41	50
5	60	77	46	33
17	50	92	46	56
15	67	74	50	55
26	50	63	31	59
33	50	70	35	40
Average	55	73	40	51
Field:				
65	37	100	37	36
58	0	81	0	40
62	0	71	0	46
163	0	82	0	--
208	0	67	0	--
170	0	68	0	--
167	6	84	5	--
164	24	70	17	--
347	0	62	0	--
Average	7	76	7	41
Total average	30	75	22	48

The difference between greenhouse and field grafts in scion-interstock compatibility, 55 percent vs. 7 percent, respectively, was highly significant (table 1). But the average compatibilities of the scion clones of greenhouse- and field-grown grafts were not significantly different when single-grafted on the rootstocks (51 percent vs. 41 percent, respectively). Therefore, the observed 55 percent vs. 7 percent difference in double-grafts was not primarily due to variation in average compatibilities of the clones tested but to other causes.

There was no correlation found between length of interstock and compatibility of scion-interstock unions in either greenhouse or field trial grafts. Interstocks of greenhouse grafts averaged 4.0 and 4.2 centimeters, and field grafts averaged 21.0 and 18.0 centimeters with compatible and incompatible unions, respectively. Neither difference was significant.

Forty-one percent of the grafts of the scion clones were compatible in the field when single-worked directly onto 5- to 8-year-old rootstocks, yet none was compatible when top-grafted on six of the nine interstocks (table 1). Using 41 percent as the expected proportion of compatible grafts, the probability that just one interstock would, by chance, be incompatible with all five scion clones is about 4 percent. The probability that this should happen six of nine times by chance is very low. An induced form of incompatibility is likely the cause of this phenomenon. Induced incompatibility refers to the condition where normally compatible graft combinations are made incompatible by factors or conditions other than the two adjacent graft components themselves. Lack of good compatibility at the upper union did not adversely affect the proportion of compatible interstock-rootstock unions (75 percent) nor the scion-rootstock unions (48 percent).

A side observation of theoretical importance was made. Past work with single-worked Douglas-fir ramets has shown uniformity in compatibility response within grafts of the same scion-rootstock combinations when grown under the same environmental conditions (unpublished data). For example, if grafts of one scion are made on five different branches of one rootstock, the five unions are either all compatible or all incompatible. Grafting scions of a given clone on an interstock should also have resulted in similar uniformity, but this did not occur within many of the combinations that had some compatible grafts. For example, two compatible and three incompatible unions were found in the five grafts of clone 2 top-grafted on interstock 10. This may be the same induced reaction noted in the field-grown grafts where six of nine interstocks were incompatible with all five scion clones, except the reaction was not as severe in the greenhouse. Only part of the grafts of each scion-interstock combination was made incompatible, whereas field grafting appeared to increase this induced incompatibility. A simple explanation of

the induced incompatibility within the scion-interstock combinations was not evident because, surprisingly, no correlation was found between the compatibility of the three unions: scion-interstock, interstock-rootstock, and scion-rootstock.

DISCUSSION

Successful interstock grafting requires good compatibility at both upper and lower unions. For a particular interstock, seven of 10 scion-interstock unions and all of the interstock-rootstock unions would have to be compatible if 70 percent (70×100) success was to be obtained. Even better compatibility would be required at the upper unions if some lower unions were incompatible. Actually, only 30 percent of the upper unions and 75 percent of the lower unions in this study were compatible; thus only 22 percent (30×75) of the double-worked ramets were compatible. The best interstock tested, interstock 15, was only 50 percent successful when double-grafted. If this method is to be successful in Douglas-fir, a widely compatible interstock is needed, such as the Old Home variety in pears (Hansen and Eggers 1951).

Although interstocks failed to improve compatibility of Douglas-fir grafts, an unusual form of induced incompatibility was suggested. The data indicate that interaction between scion-interstock-rootstock genotypes may have caused compatible combinations of scion-interstock to become incompatible. This was evident in field-grown grafts where six interstocks were totally incompatible with all five scion clones, and was further evident in many of the remaining scion-interstock combinations where lack of uniformity in compatibility was observed. This occurrence was highly divergent from the expected behavior. Cited examples of induced incompatibility are rare, but two similar examples were reported for double-grafts of peach-plum (Mosse 1960) and apples (Luckwill 1958).

In Douglas-fir, it appears that three genotypes must be arranged in a linear sequence before incompatibility is induced at the scion-interstock union. It is speculated that rootstock genotypes produce substances which are made toxic to cells of the scion-interstock unions during passage through the interstock tissues. Basipetal movement of the factor responsible for induced incompatibility probably does not occur since no apparent increase in incompatibility was noted at the interstock-rootstock unions. Prior to this study, all incompatibility symptoms in Douglas-fir seemed to fit the "localized type" described by Mosse (1962). As now demonstrated in double-grafted trees, the presence of the "translocated type" is also a possibility.

The causes of lower compatibility at the scion-interstock unions in field- vs. greenhouse-grown grafts are not known. Potential causes are differences in rootstock age, interstock length, time interval between grafting the upper and lower unions, or original environment. But since interstock length had no effect on compatibility within field-grown grafts, it seems unlikely that length is the causal factor. It seems probable that one or a combination of the other three may be at fault.

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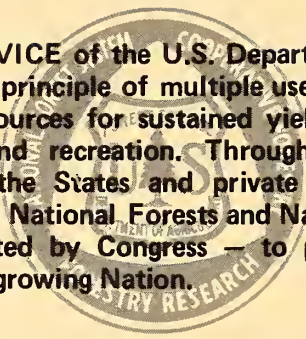
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